The NWS National Water Center

EMC Quarterly Science Briefing

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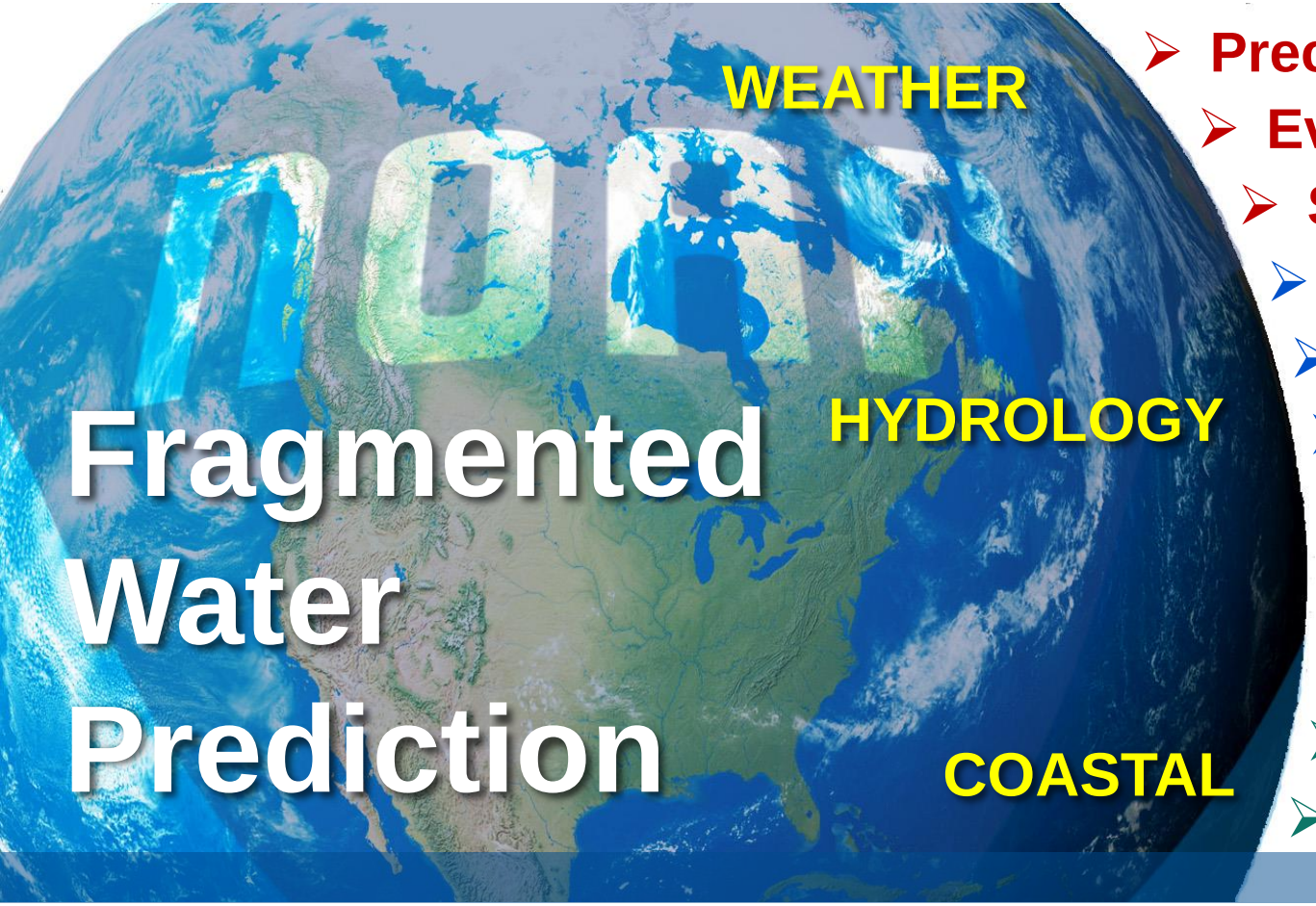
Growing Issues Facing the Nation's Water Enterprise

Impetus for Enhancing Water Prediction Services

- **Population growth, agriculture and economic development**
  - Stressing water supplies and water quality
  - Escalating socioeconomic risks of floods and droughts
- **Shifting population density**
  - Increasing vulnerabilities
  - Increased inhabitation of flood and drought prone areas
- **Changing climate**
  - Impacting water availability and quality
  - Increasing uncertainty
  - Stationarity is dead – the past is no longer prologue
- **Aging infrastructure**
  - Forcing critical, expensive decisions

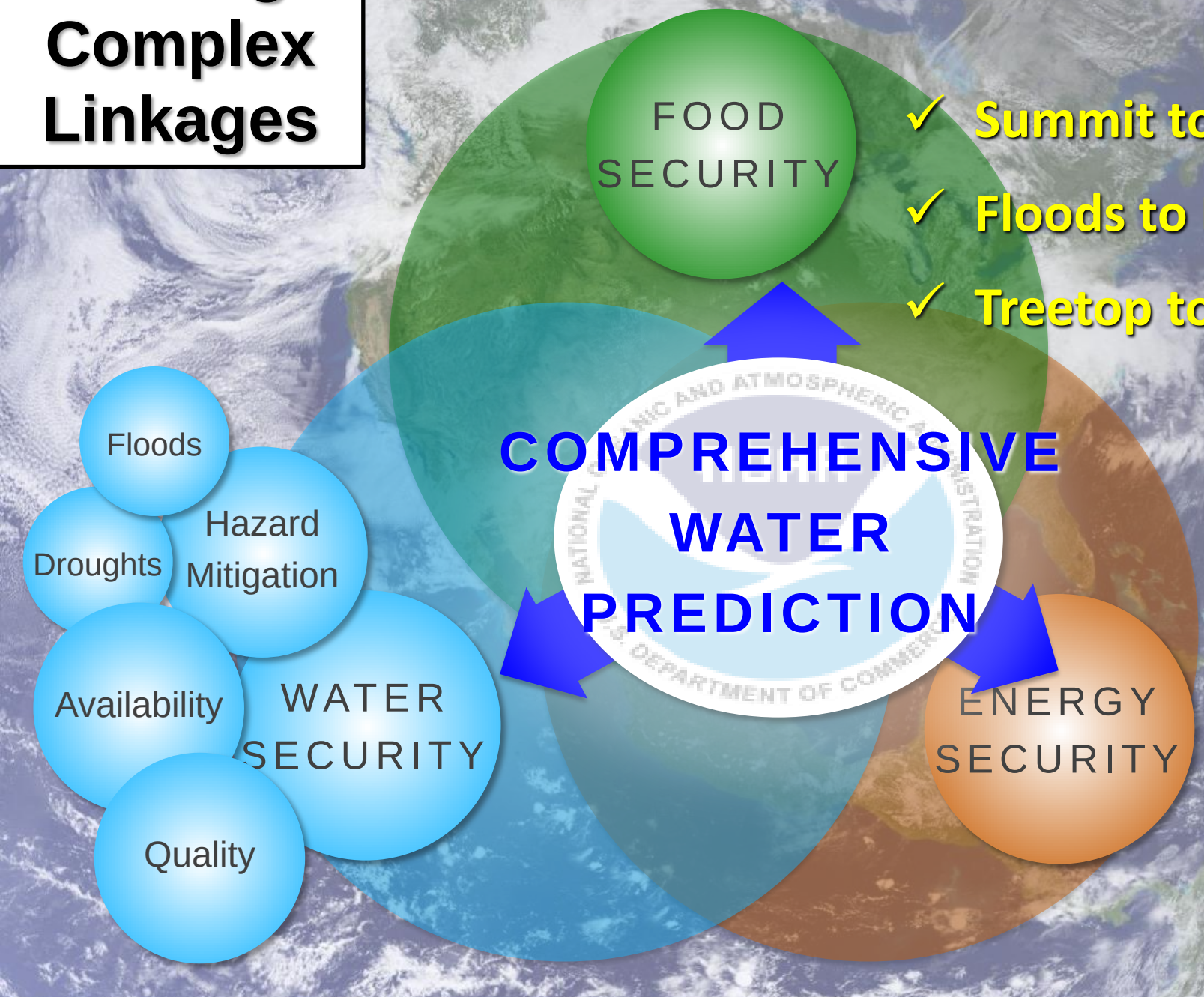
Challenge: Fragmentation



- Precipitation
- Evaporation
- Snowmelt
- Runoff
- Channel Flow
- River Flooding
- Flash Flooding
- Drought
- Storm Surge
- Tides
- Sea Level Rise

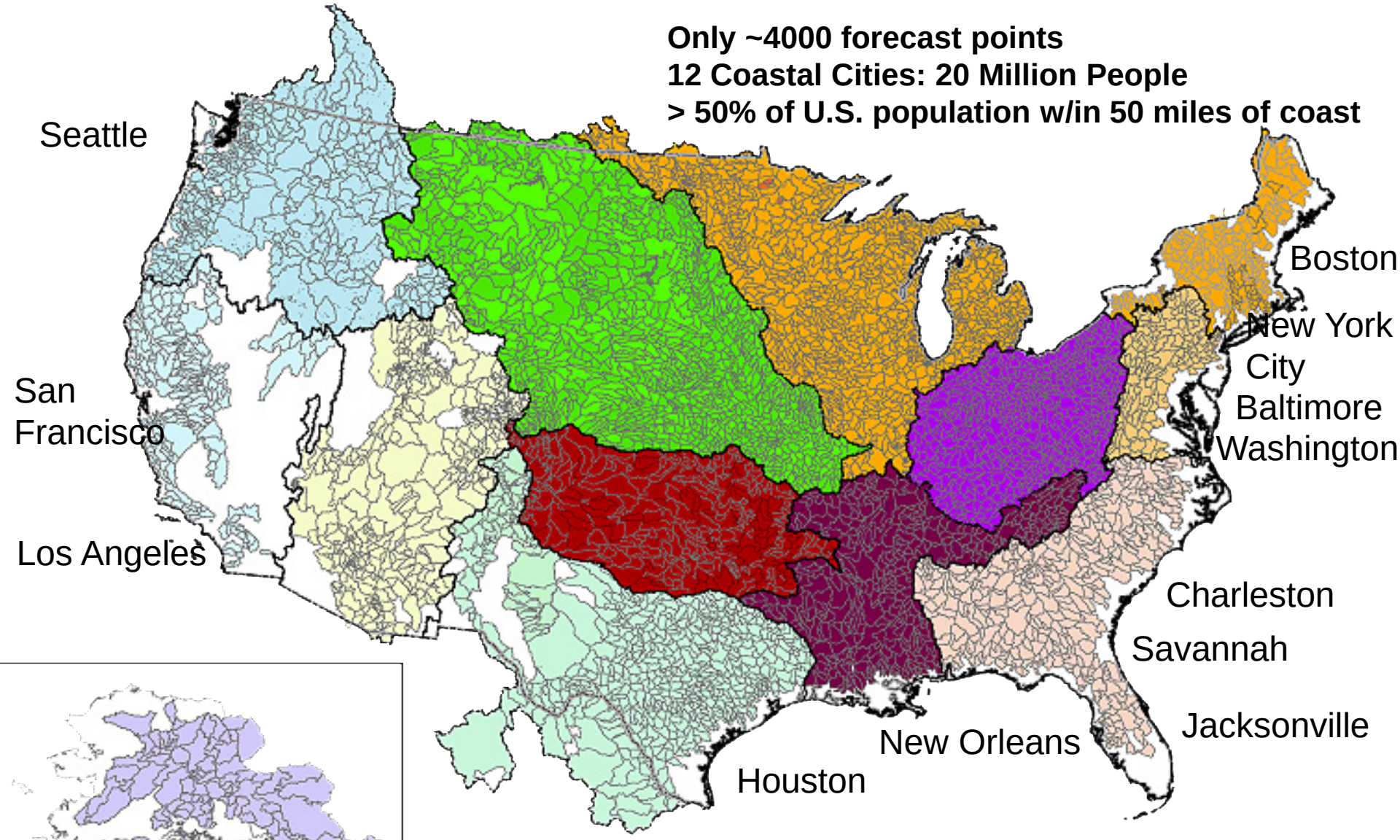
Challenge: Complex Linkages

Linking Atmosphere, Land, Ocean Modeling



- ✓ Summit to Sea
- ✓ Floods to Droughts
- ✓ Treetop to Bedrock

Challenge: Current Capabilities



A need exists to couple NWS freshwater and NOS coastal estuary prediction capabilities

How Will We Address These Challenges?
Integrated Water Resources Science and Services (IWRSS)
Partners with Complementary Missions

Water Science: to collect and disseminate reliable, impartial, and timely information needed to understand the Nation's water resources in order to minimize loss of life and property from natural disasters

US Army Corps of Engineers

Water Management: to strengthen our Nation's security, energize the economy, and reduce risks from disasters

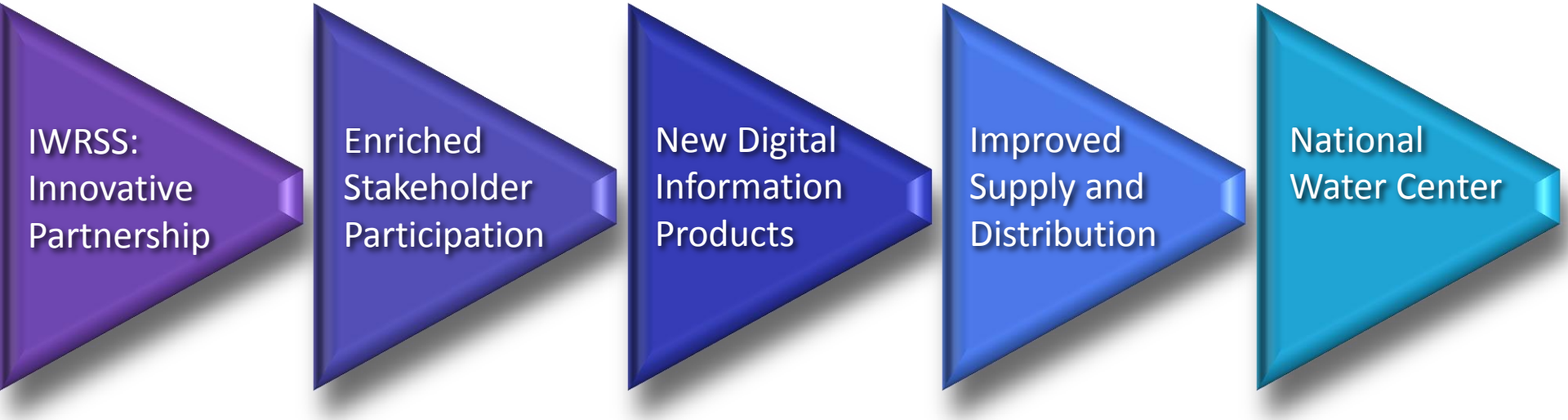
Water Prediction: to provide weather, hydrologic, and climate forecasts and warnings for the United States, its territories, adjacent waters and ocean areas, for the protection of life and property and the enhancement of the national economy

FEMA

Response and Mitigation: to support our citizens and first responders to ensure that as a nation we work together to build, sustain, and improve our capability to prepare for, protect against respond to, recover from and mitigate all hazards

IWRSS Partnership will expand over time

IWRSS Five Point Strategy



Complementing IWRSS

- **Additional partnering <u>key</u> to holistic modeling approach**
  - Internal NOAA partners (NCEP Centers, OAR Labs, NESDIS)
  - External partners (NCAR, NASA, NESDIS, Academia, Others)
  - Leverage synergistic strengths in modeling, forcing, data assimilation, validation, observing systems and delivery
  - Work towards a unified water resources message
- **Central Principle: Collaborate rather than duplicate**

National Water Center

Mission:

- The NWC collaboratively researches, develops and delivers state-of-the science, National hydrologic analyses, forecast information, data, decision-support services and guidance to support and inform essential emergency services and water management decisions.
- Through partnerships, it integrates and supports consistent water prediction activities from global to local levels.

Location: Tuscaloosa, Alabama **Full Staffing: ~200**

National Water Center Functions

- A foundation for developing a national **common operating picture** to enable critical decisions effecting the Nation's most valuable resource
- **Fully integrated water resources program** directed towards consistent products for impact-based decision support services
  - Operate a National Water Model to provide high fidelity, street level predictions linked to impacts for enhanced decision support
  - Integrated data services, data archive, verification/validation, service backup
- Catalyst for **accelerating research to operations** and **strengthening partnerships** through operational proving ground
- Nerve center for **data integration and water prediction** among RFCs and IWRSS partners

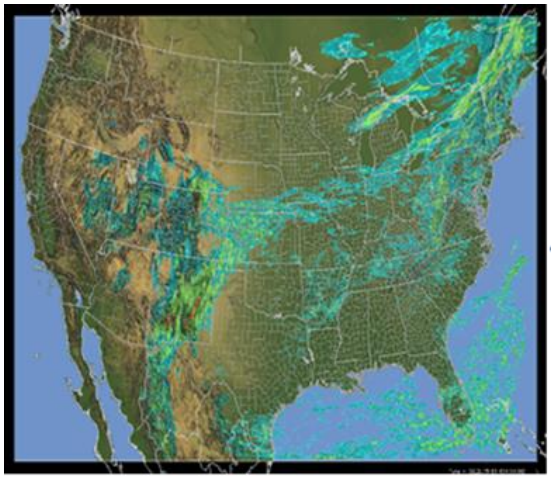
NWC Hydrologic Mission and Resulting Model Needs

	Mission Requirement	Resulting Model Attribute	Source of Requirement
Operational Status/Forecast Length	NWC Operational extended range water resource forecasts	Operational**, ensemble 30 day** streamflow simulations	Army Corps, River Basin Commissions, regional stakeholders
	NWC Operational products to inform National Hydrologic Assessment	Operational, high resolution hydrologic ensemble and **med-range deterministic** runs	NWS via Senate request
Forecast Frequency/Forecast Length	High frequency, real-time flash flood forecasts	Multiple **short-range deterministic** runs each day	NWS service assessments, FEMA and stakeholder summits and dialog
Domain Size	Seamless CONUS-scale water resources guidance products	**CONUS-scale** implementation	Intergovernmental activities, stakeholder assessment, and Flash Flood Summit attendees
Resolution	Street-level flood forecasts	**250 meter streamflow** resolution, **1km LSM** resolution	NWS service assessments, congressional testimony, emergency managers
Resolution/Potential for Integration	Support of dynamic flood inundation mapping	250m resolution, sfc water depth output, **hooks for hydraulic coupling** and FEMA National Flood Hazard Layer	FEMA, river basin commissions, National Flood Interoperability Experiment
Resolution/Potential for Integration	Fully coupled river-to-estuary modeling	250 meter resolution enabling accurate representation of outflow channels, WRF-Hydro coupling framework	Supports NOAA strategic goals, service assessments, Flash Flood Summit attendees
Regulation/Resolution	Representation of regulation (reservoirs, water transfers)	Inclusion of high resolution **reservoirs** in modeling system and **assimilation of streamflow observations**	River basin commissions, regional stakeholders, NWS
Data Assimilation	Data assimilation to incorporate observations	Assimilation of streamflow and other observations into **hourly analysis**, ingest of WaterML2 data on WCOSS	Flash Flood Summit, IWRSS IDS requirements report

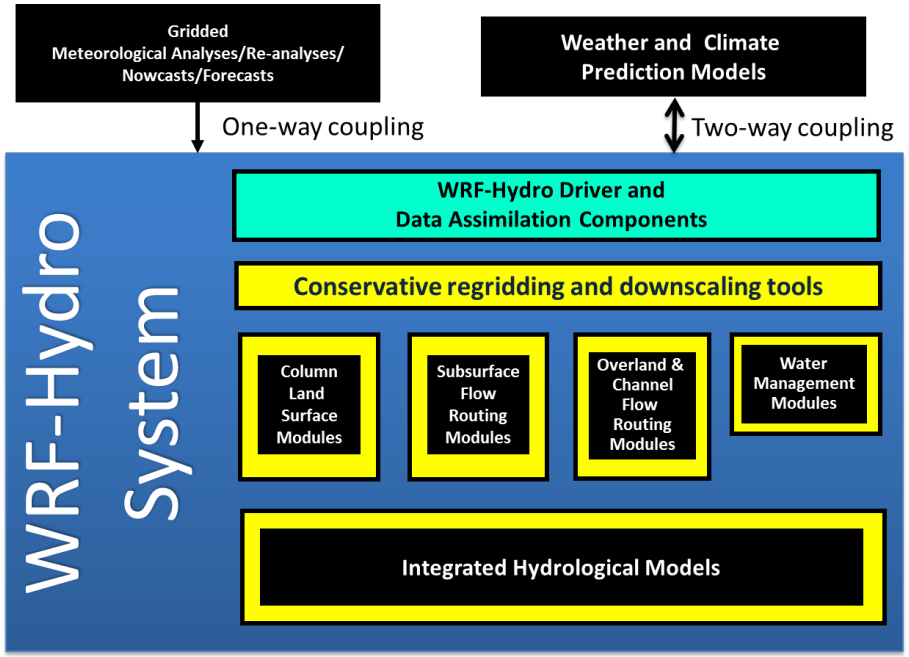
Water Resource Forecasting with WRF-Hydro

- WRF-Hydro: A modular multi-scale and multi-physics land-atmosphere modeling framework supporting assimilation and coupled and uncoupled prediction of major water cycle components
- NWC Configuration
  - CONUS domain, uncoupled configuration using the Noah-MP LSM
  - 1km LSM resolution, routed streamflow on 250m grid and ~2.5 million catchments
  - Deterministic and ensemble forecasts, analysis cycle with streamflow assimilation
  - Currently scheduled for implementation on WCOSS on January 19th, 2016

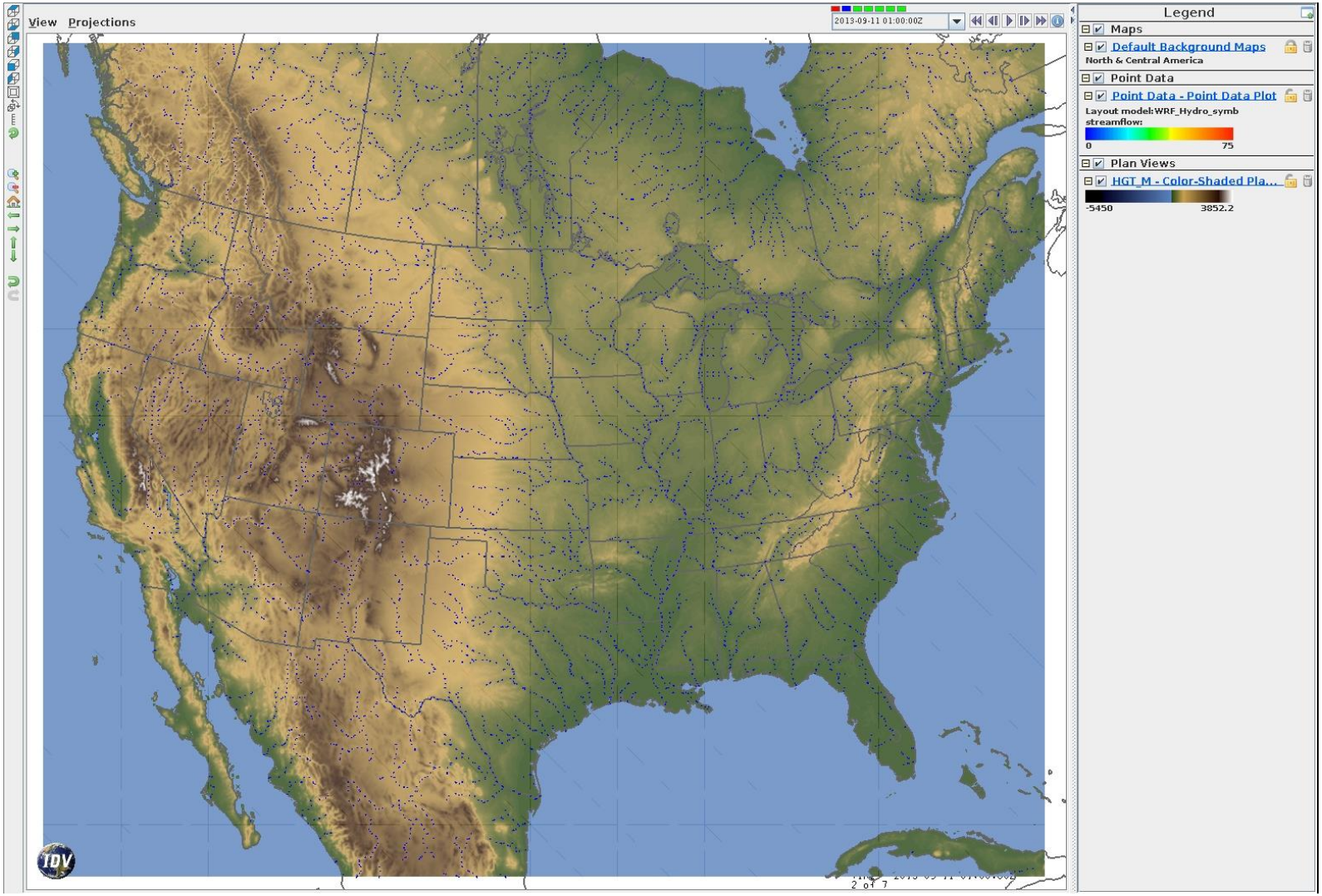
Operational Weather & Climate Predictions



1-10's km



National Centralized Modeling with WRF-Hydro



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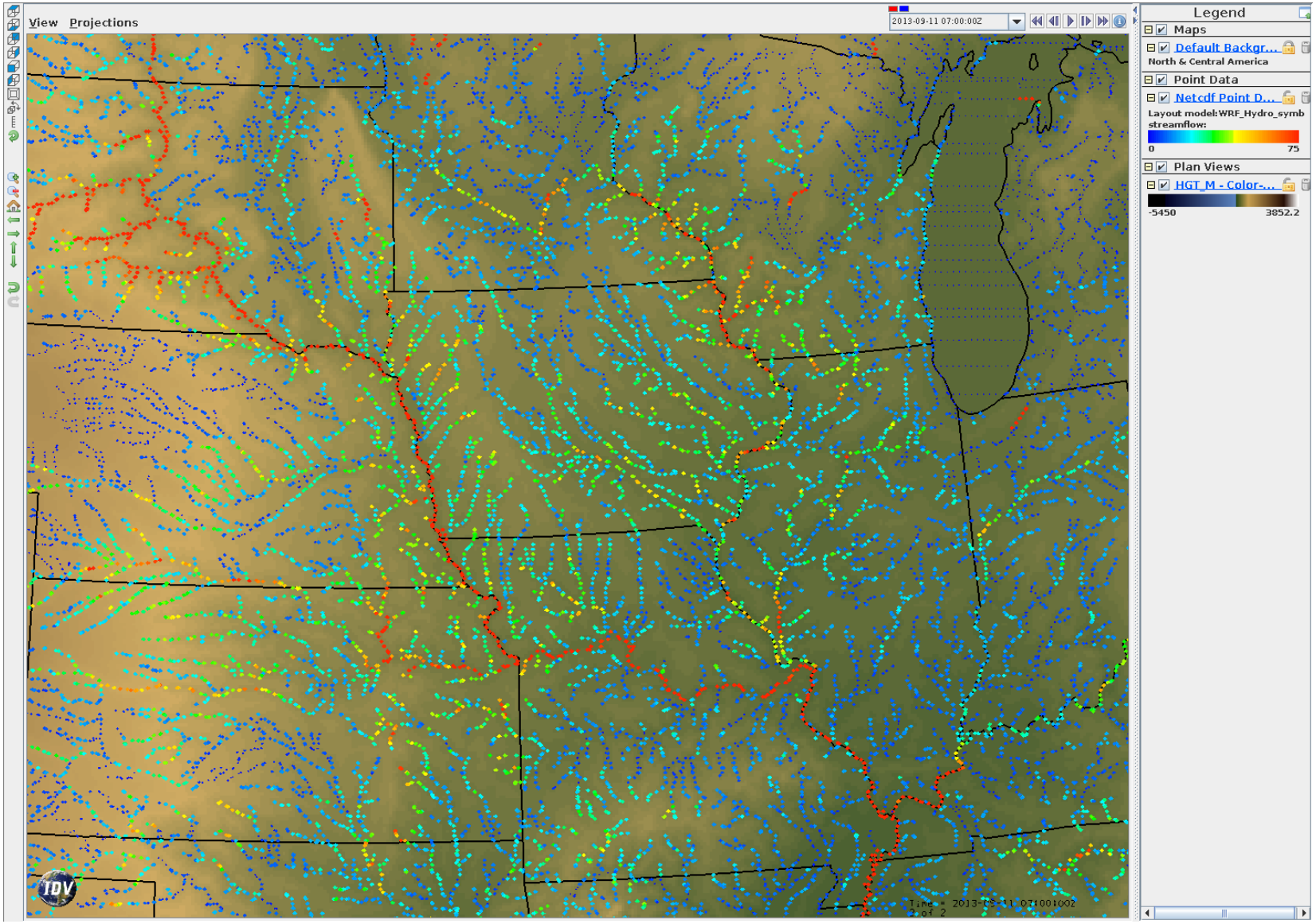

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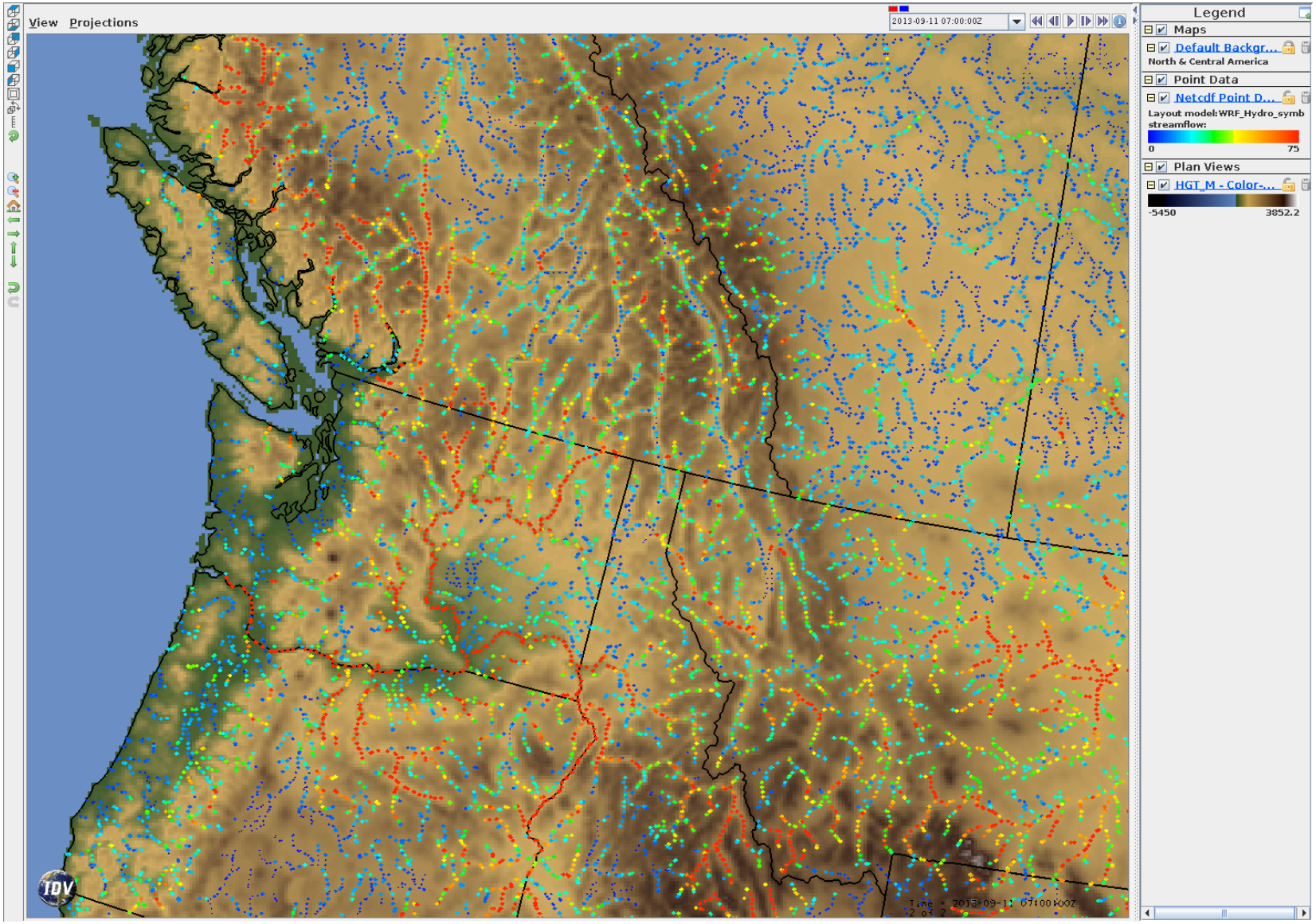

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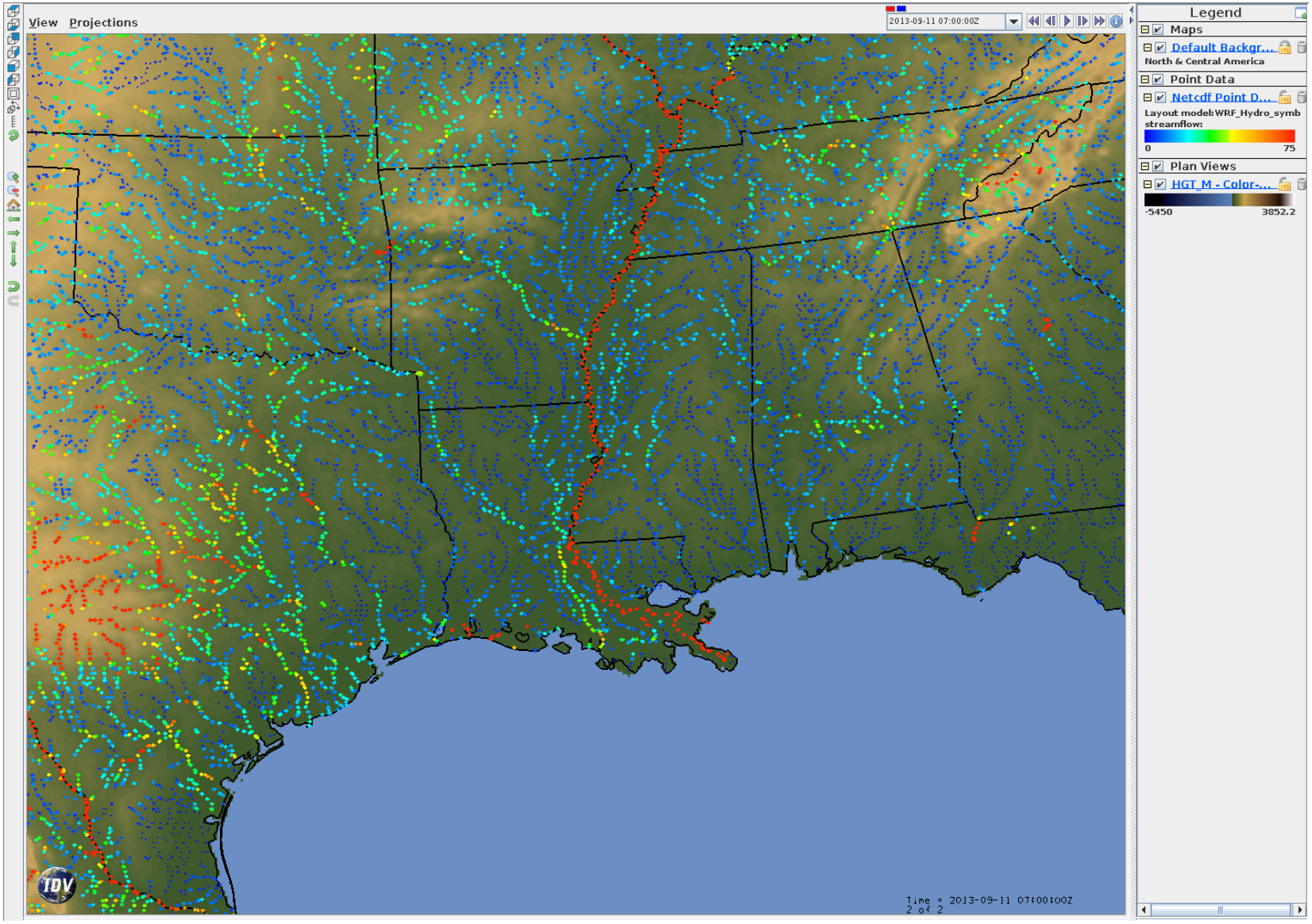


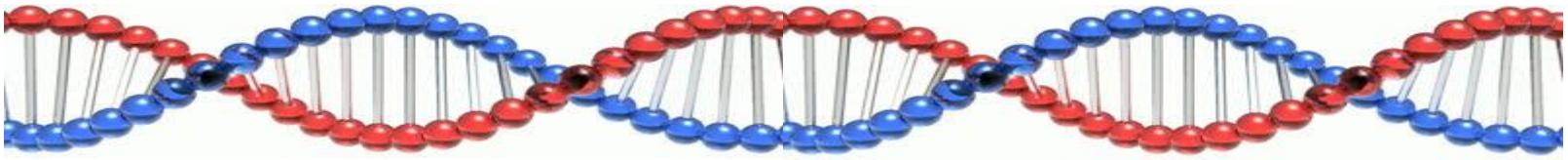
Potential Areas of NWC – EMC Collaboration

- Forcing Data Development
  - ★ Guidance on choice of EMC models for forcing WRF-Hydro
  - ★ Use of NLDAS2 downscaling techniques by WRF-Hydro
  - ★ Use of NWC historical manually digitized radar in NLDAS3
  - – Joint development of real-time and retrospective forcing datasets
- ★ Support of NWC/RFC HEFS ensemble forecasting system via GEFS and CFS
- Hydrologic modeling
  - – Hydrologic enhancements to NLDAS3 (routing, models)
  - ★ Common approach to model validation (WRES Kickoff-March 2015)
  - ★ Development and benchmarking of Noah-MP LSM
  - – Construction of next generation high resolution watershed model
  - – Development of coordinated cross-resolution hydrologic modeling approach (i.e., global to catchment)
  - – Coupled river-ocean-estuary modeling and earth system modeling
- Noah-MP Proposals
  - ★ Dynamic GVF assimilation (GSFC, EMC, NWC, NCAR)
  - ★ Snow cover and depth assimilation (NCAR, NWC, EMC, GSFC)
- Journal Articles
  - ★ NLDAS2 water and energy balance
  - – Many additional possibilities

★ = Underway

Collaboration Paradigm: Close coordination with two-way flow

EMC



NWC

Collaboration Resources

- NWC
  - Liaison stationed in NCWCP one day per week
  - Emerging forcing, modeling, verification and GIS project teams
- EMC
  - Short Range (~12 months)
    - Staff time to co-develop forcing data sets (small increase)
    - Minor staff time to advise on implementation of WRF-Hydro
  - Long Range
    - Less defined and still subject to in-depth planning
    - Mixture of staff time, data and code
    - Increase in two-way liaison activities

Summary

- **An evolving water mission**
  - Deliver comprehensive, integrated actionable water resource guidance
  - Summit-to-Sea, Floods to Droughts, Treetops to Bedrock
- **Implementing State-of-the-Art Technical Approach**
  - NWC and EMC need to be close partners
  - Water prediction through Earth System modeling
  - Impact-based decision support underpinned by GIS geo-intelligence
- **Scale Change: Orders of Magnitude More Data**
  - Reach-based “Street Level” prediction
  - Utilization of High Performance Computing
- **New organization, cornerstone facility and philosophy**
  - National Water Center
  - Collaborative, cross-NOAA, interagency, academic partnerships
- **Incorporation of street-level hydrology into fabric of NOAA Enterprise**